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Original Article

Prevalence of Dental Caries and Dental Fluorosis among 12 and 15 Years Old School Children in Relation to Fluoride Concentration in Drinking Water in an Endemic Fluoride Belt of Andhra Pradesh

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Abstract

Background: The published literature on the prevalence and severity of dental caries and dental fluorosis among school going children in Nalgonda district – An Endemic Fluoride belt was lacking**. Objectives:** To assess the prevalence and severity of dental fluorosis and dental caries among 12 and 15 years old children in relation to fluoride concentration in drinking water**. Settings and Design:** It was a cross-sectional study, done in Nalgonda district of Andhra Pradesh, India (endemic fluoride belt)**. Materials and Methods:** 5 of the 59 mandals in the district of Nalgonda were selected by simple random sampling. Then, 3 schools from each of these selected mandals were chosen at random. All the eligible 6th and 9th standard children were considered for final analysis. The demographic and other relevant information was collected by 3 trained and calibrated dentists, using a structured questionnaire. Dental caries were recorded using dentition status and treatment needs and fluorosis were recorded by Dean's fluorosis index. The statistical analysis was done using SPSS version 16. **Results:** The prevalence of dental caries among children was 56.3% with the highest in below optimal fluoride area (71.3%) and lowest in optimal fluoride area (24.3%). The prevalence of dental fluorosis was 71.5%. The prevalence was 39.7% in below optimal fluoride area and 100% in high and very fluoride areas. The prevalence and severity of fluorosis increased with increasing fluoride concentration. The caries experience was more among boys than girls. **Conclusion:** There was a negative correlation between dental caries and fluoride concentration for the entire study population. However, in high fluoride areas, there was a positive correlation between fluoride concentration and dental caries. Water defluoridation on an urgent basis is a priority here than water fluoridation, because the prevalence and severity of dental flurorosis is very high.

Key words: Dental caries, Dental fluorosis, Defluoridation, Endemic fluoride belt, Prevalence

Introduction

Dental caries is an ancient disease, dating back to the time that agriculture replaced hunting and gathering as the principle source of food, although the prevalence and severity was much lower than what we see today. Though the recent reports demonstrate a decline in the dental caries trend in most developed nations, mainly attributed to the use of fluorides in different forms,[1] it is still existing as a disease of high propensity in many underdeveloped and developing countries of Africa and Asia including India due to lack of public awareness and motivation, inadequate resources for sophisticated dental treatments and changing dietary habits.[2] Indeed, the use of fluorides is recognized as one of the most successful measures for caries prevention in the history of public health.

But, "*fluoride is often termed a double edged weapon*"– the optimal and judicious use of which offers maximum

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caries protection, whereas injudicious and excessive systemic consumption may lead to chronic fluoride toxicity, which manifest as dental and skeletal fluorosis.[3] In the light of this, the more precise definition of optimum fluoride concentration in drinking water (which is not a universal constant, and which varies with the environmental conditions) becomes all the more important. Human clinical trials on this may not be feasible because of ethical and many other practical obstacles. Endemic fluoride belts serve as natural laboratories to study the effect of fluoride concentration on dental caries and dental fluorosis simultaneously.[4]

Nalgonda district of Andhra Pradesh has been cited as an endemic fluoride belt in some of the literature in the past. But, the literature on the prevalence of dental caries and dental fluorosis among school going children in this area, where the fluoride concentration in drinking water ranges from as low as 0.2 PPM (parts per million) to as high as 12 PPM is scanty. This prompted us to take up the present study with an objective of determining the prevalence of dental caries and dental fluorosis among 12 and 15 years old school children, living in different fluoride areas of Nalgonda district.

Materials and Methods

The study was cross-sectional in nature, and an ethical clearance was obtained from the institutional ethical committee. The study was conducted over a period of 6 months from March 2008 to August of the same year. The information on the total number of secondary schools in each of the 59 mandals (an administrative division, consisting of many villages) of Nalgonda district was obtained from the office of district education officer, Nalgonda. 5 of these mandals were selected by simple random sampling technique. Then, all the secondary schools in the selected mandals were listed out. 3 secondary schools from each of these selected mandals were again selected by using lottery method of simple random sampling technique. All the 6th and 9th standard children, who were continuous residents in these places and who were available on the day of examination, were considered for the study. A total of 2396 students were present in these 15 selected schools on the days of examination. Among them, 2316 students fulfilled the inclusion criteria (continuous residents in these areas), and these children only were considered for final analysis. After obtaining consent from the concerned school authorities, the examination was done by 3 trained and calibrated dentists, using a mouth mirror and C P I probe (community periodontal probe – used for detecting dental caries) under natural day light, on a portable chair within the school premises. The inter examiner agreement was 91%. The pre-survey kappa statistic for intra examiner consistency was found to be acceptable for both dentition status and treatment needs ($K = 0.89$) and dental fluorosis index ($K = 0.83$). About 5% of the population examined on each day, were re-examined by the same investigators at the end of the day to check the intra examiner consistency, and these data were entered on duplicate record sheets. The data entered in the repeat examination was cross-checked in comparison with the original data sheet of these subjects by a faculty from the department of orthodontics, and discrepancies, if any, in the 2 recordings were noted. The kappa statistic for all the repeat examinations clubbed together was 0.93 for dentition status and treatment needs, and 0.87 for dental fluorosis index. The demographic details and the information on oral hygiene practices, dietary habits, sweet consumption, source of drinking water, and amount of liquid consumed in a day, use of fluoridated tooth paste etc. was collected by the examiners using a questionnaire. The dental caries experience was recorded using dentition status and treatment needs. The severity of dental fluorosis was assessed using dental fluorosis index with Dean's criteria.[5] Dean's fluorosis index measures severity of dental fluorosis on a scale, ranging from 0 to 4 (0 - normal enamel, 0.5 – questionable fluorosis with occasional white fleck or spot, 1 - very mild fluorosis with white opacities covering less than 25%, 2 - mild fluorosis with opacities covering more than 25%, but less than 50%, 3 - moderate fluorosis with brown staining, 4 - severe fluorosis with confluent pitting and corroded appearance). The community fluorosis index score (CFI) was computed using the equation CFI = frequency X weight / number of individuals examined. Community fluorosis index denotes the public health significance of dental fluorosis in an area (0 to 0.4 – negative, 0.5 - border line significance. 0.6 to 1 - slight, 1.1 to 2 – medium, 2.1 to 3 – marked, 3.1 to 4 – very marked public health significance). Dental caries was diagnosed at cavitation level where discoloration, definite catch and softened dentin existed. The tooth was recorded to be sound whenever the doubt existed in the fulfillment of the criteria for diagnosing the carious lesions. The DMFT value for a subject was computed by taking the sum of untreated carious teeth (D component), teeth

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missing because of dental caries (M component) and teeth restored with permanent restorations because of dental caries (F component). The DMFT value denotes the overall dental caries experience (past and present caries experience) in the subject. The water samples of the respective sources, from where the families of these children fetched water (community source), were collected in clean plastic bottles of 500 ml capacity after the completion of clinical examination of the children. These bottles were coded, and submitted to laboratory for assessment of fluoride in the drinking water. The fluoride assessment was done using Orion 720A fluoride meter, coupled with ion specific electrode. Based on the fluoride concentration in the drinking water, the study population was divided into 5 categories viz. below optimal fluoride area (fluoride concentration - < 0.7 PPM), optimal fluoride area (0.7 – 1.2 PPM), above optimal fluoride area (1.2 PPM - 2 PPM), high fluoride area (2.1 – 4 PPM) and very high fluoride area (4.1 PPM and above). The data was analyzed using SPSS version 16. The quantitative data was expressed in terms of mean and standard deviation. The categorical data was expressed in frequencies and percentages. ANOVA was used for comparing mean from more than 2 groups. Wherever ANOVA was found to be significant, post hoc Tukey's test was used for multiple pair-wise comparisons. Categorical data was analyzed using Chi-square test. Pearson's correlation co-efficient was used for correlation between fluoride concentration and DMFT as well as CFI. The statistical significance was set at 0.05. The instrument sterilization was done using hot water sterilizer, and in the absence of electricity, 2.45% glutaraldehyde (Cidex) was used for 10 - 15 minutes.

Results

The age and sex distribution of the study population in different fluoride areas is denoted in Table 1. The overall prevalence of dental caries in the study was 56.3%. The highest caries prevalence was noticed in below optimal fluoride area (71.3%) and the lowest caries prevalence was noted in optimal fluoride area (24.3%). The difference was statistically significant (P = 0.000, Table 2). The same result was found even when the comparison was made among different age and sex groups' separately. The prevalence of dental caries was significantly more among males (59%) compared females (53.5%), and there was no statistically significant difference in caries prevalence between 12 and 15 years groups (P = 0.379, Table 2). The prevalence of dental fluorosis in the study population was 71.5%. The prevalence was 39.7% in below optimal fluoride area and 100% in high and very fluoride areas. The difference was statistically significant (P = 0.000, Table 3). There was no statistically significant difference in the prevalence of dental fluorosis between the gender and age groups (P = 0.536 and 0.108, respectively for gender and age, Table 3). The severity of dental fluorosis increased with increasing concentration of fluoride in the drinking water. The study population had a mean DMFT score of 0.83 with a standard deviation of 0.92. The mean DMFT score was highest in very high fluoride area (1.27 ± 1.13), followed by below optimal fluoride area (1.07 ± 0.92**)**. The lowest value was observed in optimal fluoride area (0.28 ± 0.54). The difference in mean DMFT scores between different fluoride areas was statistically significant when tested by One way ANOVA (P = 0.000). Tukey's post hoc test revealed a significant

Table 1: Age and sex distribution of the study population if different fluoride areas

Fluoride area	12 years			15 years			Total		
	M N (%)	F N (%)	M and F combined N (%)	M N (%)	F N (%)	M and F combined N (%)	M N (%)	F N (%)	M and F combined N (%)
Below optimal	239 (45.3)	232 (37.8)	471 (41.2)	259 (41.2)	242 (44.4)	499 (42.6)	498 (43)	474 (40.9)	972 (42)
Optimal	96 (18.2)	155 (25.2)	251 (22)	175 (27.8)	121 (22.2)	296 (25.3)	271 (23.4)	276 (23.8)	547 (23.6)
Above optimal	24 (4.5)	33 (5.4)	57 (5)	13 (2.1)	8 (1.5)	21 (1.8)	37 (3.2)	41 (3.5)	78 (3.4)
High fluoride area	85 (16.1)	110 (17.9)	195 (17.1)	100 (15.9)	120 (22)	220 (18.8)	185 (16)	230 (19.8)	415 (17.9)
Very high fluoride area	84 (15.9)	84 (13.7)	168 (14.7)	82 (13)	54 (9.9)	136 (11.6)	166 (14.3)	138 (11.9)	304 (13.1)
Total	528 (100)	614 (100)	1142 (100)	629 (100)	545 (100)	1172 (100)	1157 (100)	1159 (100)	2316 (100)

M - Males, F - Females, N - Frequency, % - Percentage

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Table 2: Prevalence of dental caries among the study population in different fluoride areas

Fluoride area	12 years						15 years						Overall (age combined)					
	M N (%)		F N (%)		M and F combined N (%)		M N (%)		F N (%)		M and F combined N (%)		M N (%)		F N (%)		M and F combined N (%)	
	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)
Below optimal	72 (30.1)	167 (69.9)	67 (28.9)	165 (71.1)	139 (29.5)	332 (70.5)	64 (24.9)	193 (73.1)	74 (30.6)	168 (69.4)	138 (27.7)	361 (72.3)	138 (27.7)	360 (72.3)	141 (29.7)	333 (70.3)	279 (28.7)	693 (71.3)
Optimal	71 (74.0)	25 (26.0)	119 (76.8)	36 (23.2)	190 (75.7)	61 (24.3)	132 (75.4)	43 (24.6)	92 (76.0)	29 (24.0)	224 (75.7)	72 (24.3)	203 (74.9)	68 (25.1)	211 (76.4)	65 (23.6)	414 (75.7)	133 (24.3)
Above optimal	16 (66.7)	8 (33.3)	25 (75.8)	8 (24.2)	41 (71.9)	16 (28.1)	8 (61.5)	5 (38.5)	5 (62.5)	3 (37.5)	13 (61.9)	8 (38.1)	24 (64.9)	13 (35.1)	30 (73.2)	11 (26.8)	54 (69.2)	24 (30.8)
High fluoride area	32 (37.6)	53 (62.4)	42 (38.2)	68 (61.8)	74 (37.9)	121 (62.1)	39 (39.0)	61 (61.0)	56 (46.7)	64 (53.3)	95 (43.2)	125 (56.8)	71 (38.4)	114 (61.6)	98 (42.6)	132 (57.4)	169 (40.7)	246 (59.3)
Very high fluoride area	25 (29.8)	59 (70.2)	41 (48.8)	43 (51.2)	66 (39.3)	102 (60.7)	13 (15.9)	69 (84.1)	18 (33.3)	36 (66.7)	31 (22.8)	105 (77.2)	38 (22.9)	128 (77.1)	59 (42.8)	79 (57.2)	97 (31.9)	207 (68.1)
Overall	216 (40.9)	312 (59.1)	294 (47.9)	320 (52.1)	510 (44.7)	632 (55.3)	256 (40.8)	371 (59.2)	245 (45.0)	300 (55.0)	501 (42.7)	671 (57.3)	474 (41)	683 (59)	539 (46.5)	620 (53.5)	1013 (43.7)	1303 (56.3)
Statistical inference	*P* = 0.000		*P* = 0.000		*P* = 0.000		*P* = 0.000		*P* = 0.000		*P* = 0.000		*P* = 0.000		*P* = 0.000		*P* =0.000	

P value between males and females (with age combined) = 0.007, *P* value between 12 years and 15 years (with sex combined) = 0.379, M - Males, F - Females, N - Frequency, % - Percentage, No – Caries absent, Yes – Caries Present

Table 3: Prevalence of dental fluorosis among the study population in different fluoride areas

Fluoride area	12 years						15 years						Overall (age combined)					
	M N (%)		F N (%)		M and F combined N (%)		M N (%)		F N (%)		M and F combined N (%)		M N (%)		F N (%)		M and F combined N (%)	
	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)
Below optimal	128 (53.6)	111 (46.4)	140 (60.3)	92 (39.7)	268 (56.9)	203 (43.1)	160 (62.3)	97 (37.7)	156 (64.5)	86 (35.5)	316 (63.3)	183 (36.7)	290 (58.2)	208 (41.8)	296 (62.4)	178 (37.6)	586 (60.3)	386 (39.7)
Optimal	13 (13.5)	83 (86.5)	27 (17.4)	128 (82.6)	40 (15.9)	211 (84.1)	18 (10.3)	157 (89.7)	14 (11.6)	107 (88.4)	32 (10.8)	264 (89.2)	31 (11.4)	240 (88.6)	41 (14.9)	235 (85.1)	72 (13.2)	475 (86.8)
Above optimal	0 (0)	24 (100)	0 (0)	33 (100)	0 (0)	57 (100)	2 (15.4)	11 (84.6)	0 (0)	8 (100)	2 (9.5)	19 (90.5)	2 (5.4)	35 (94.6)	0 (0)	41 (100)	2 (2.6)	76 (97.4)
High fluoride area	0 (0)	85 (100)	0 (0)	110 (100)	0 (0)	195 (100)	0 (0)	100 (100)	0 (0)	120 (100)	0 (0)	220 (100)	0 (0)	185 (100)	0 (0)	230 (100)	0 (0)	415 (100)
Very high fluoride area	0 (0)	84 (100)	0 (0)	84 (100)	0 (0)	168 (100)	0 (0)	82 (100)	0 (0)	54 (100)	0 (0)	136 (100)	0 (0)	166 (100)	0 (0)	138 (100)	0 (0)	304 (100)
Overall	141 (26.7)	387 (73.3)	167 (27.2)	447 (72.8)	308 (27)	834 (73)	180 (28.7)	447 (71.3)	170 (31.2)	375 (68.8)	350 (29.9)	822 (70.1)	323 (27.9)	834 (72.1)	337 (29.1)	822 (70.9)	660 (28.5)	1656 (71.5)
Statistical inference	*P* = 0.000		*P* = 0.000		*P* = 0.000		*P* = 0.000		*P* = 0.000		*P* = 0.000		*P* = 0.000		*P* = 0.000		*P* = 0.000	

P value between males and females (with age combined) = 0.536, *P* value between 12 years and 15 years (with sex combined) = 0.108, M - Males, F - Females, N - Frequency, % - Percentage, No = Fluorosis absent, Yes = Fluorosis present

difference between different categories except between optimal and above optimal fluoride areas (P = 0.988). The finding was same even when the comparison was made among different age and sex groups separately. The mean DMFT score was significantly more among males (0.91 ± 0.98) compared to females (0.75 ± 0.84), (P = 0.000). There was no statistically significant difference in the mean DMFT scores between 12 (0.85 ± 0.94) and 15 years (0.82 ± 0.89) groups (P = 0.433) [Table 4]. The lowest mean DMFT score (0.12 ± 0.43) was recorded at a concentration of 1.1 PPM. The highest mean DMFT score (1.30 ± 1.06) was recorded at a concentration of 4.88 PPM. The community fluorosis index score was lowest (0.07) at 0.37 PPM and highest

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Table 4: Distribution of DMFT scores among the study population in different fluoride areas

Fluoride area	12 years			15 years			Overall (age combined)		
	M $\bar{X}$ ± SD	F $\bar{X}$ ± SD	M and F combined $\bar{X}$ ± SD	M $\bar{X}$ ± SD	F $\bar{X}$ ± SD	M and F combined $\bar{X}$ ± SD	M $\bar{X}$ ± SD	F $\bar{X}$ ± SD	M and F combined $\bar{X}$ ± SD
Below optimal	1.17 ± 1.02	1.06 ± 0.91	1.11 ± 0.97	1.15 ± 0.98	0.91 ± 0.75	1.04 ± 0.88	1.16 ± 0.99	0.98 ± 0.84	1.07 ± 0.92
Optimal	0.29 ± 0.52	0.26 ± 0.51	0.27 ± 0.51	0.31 ± 0.60	0.26 ± 0.50	0.29 ± 0.55	0.30 ± 0.56	0.26 ± 0.50	0.28 ± 0.54
Above optimal	0.33 ± 0.48	0.27 ± 0.52	0.30 ± 0.49	0.46 ± 0.66	0.38 ± 0.52	0.43 ± 0.59	0.38 ± 0.54	0.29 ± 0.51	0.33 ± 0.53
High fluoride area	0.76 ± 0.68	0.90 ± 0.93	0.84 ± 0.83	0.77 ± 0.84	0.61 ± 0.63	0.68 ± 0.73	0.77 ± 0.77	0.75 ± 0.80	0.76 ± 0.78
Very high fluoride area	1.31 ± 1.18	0.96 ± 1.08	1.14 ± 0.88	1.60 ± 1.12	1.17 ± 0.99	1.43 ± 1.08	1.45 ± 1.16	1.04 ± 1.05	1.27 ± 1.13
Overall	0.93 ± 0.98	0.77 ± 0.91	0.85 ± 0.94	0.90 ± 0.98	0.72 ± 0.76	0.82 ± 0.89	0.91 ± 0.98	0.75 ± 0.84	0.83 ± 0.92
Statistical inference	*P* value = 0.000	*P* value = 0.000	*P* value = 0.000	*P* value = 0.000	*P* value = 0.000	*P* value = 0.000	*P* value = 0.000	*P* value = 0.000	*P* value = 0.000

Independent sample t-test between males and females: *T* = 4.316, *D F* = 2314, *P* = 0.000, Independent sample t-test between 12 and 15 years: *T* = 0.783, *D F* = 2314, *P* = 0.433 (NS), Pearson's correlation between Fluoride concentration and DMFT score: -0.118, *P* = 0.000, Pearson's correlation between Fluoride concentration and DMFT score in high fluoride area: 0.153, *P* = 0.002, Pearson's correlation between Fluoride concentration and Community fluorosis index score: 0.883, *P* = 0.000, Mean Community Fluorosis index for the study population = 1.579, M - Males, F - Females, μ - Mean, SD – Standard deviation

(3.49) at 4.88 PPM. The community fluorosis index score increased with an increasing concentration of fluoride in the drinking water. When the fluoride concentration in the drinking water was correlated with DMFT score to know the influence of water fluoride concentration on dental caries, there was a weak, but statistically significant negative correlation between fluoride concentration in drinking water and mean DMFT score for the entire study population (Pearson's correlation co-efficient = -0.118, *P* = 0.000) [Table 4]. There was weak and statistically significant positive correlation between fluoride concentration and DMFT score in high fluoride areas (Pearson's correlation co-efficient = 0.153, *P* = 0.002) [Table 4]. The correlation between fluoride concentration and mean community fluorosis index (denoting the severity of dental fluorosis) was strong positive (Pearson's correlation co-efficient = 0.883, *P* = 0.000) [Table 4]. There was no statistically significant difference between different fluoride areas with respect to dietary habits, sweet consumption, socio-economic status, oral hygiene practices and the amount of liquids consumed.

Discussion

The earth's crust in India has about 12 of the 85 million tons of fluoride found throughout the world. Therefore, it is not surprising that 17 states in India are endemic for fluorosis. The state of Andhra Pradesh is one such severely affected endemic fluoride belts in the country.[6] The minimal literature on the prevalence and severity of dental caries and dental fluorosis among the school children in the district of Nalgonda, one of the worst affected in the state, led us to take up this project. We examined 12 and 15 years old children in the study as both these age groups are among the 5 index age groups, specified by World Health Organization for basic oral health surveys. 12 years group is also the global monitoring age for comparing dental caries status between the nations, and 15 years is the last feasible age group for drawing a reliable sample from the school system. Moreover, dental fluorosis is more common in permanent dentition than in deciduous dentition, and all the permanent teeth would have erupted by 12 years, except third molars. The mean DMFT score was highest in very high fluoride area (1.27 ± 1.13), followed by below optimal area (1.07 ± 0.92) and lowest in optimal fluoride area (0.28 ± 0.54). The highest caries prevalence was noticed in below optimal fluoride area (71.3%), followed by very high fluoride area (68.1%). The lowest caries prevalence was noted in optimal fluoride area (24.3%). Overall, the caries experience (mean DMFT and prevalence of dental caries) was more in very high fluoride area and below optimal fluoride area than in other areas. In very high fluoride area, individual subjects having caries experience had more number of teeth that are decayed, missing or filled in them giving a higher mean DMFT value, whereas the number of individuals showing an evidence of caries either in the form of untreated caries (D) or missing tooth (M) or filled tooth (F) (caries prevalence) was more in below optimal fluoride areas. Dental caries is a multifactorial disease where age and sex themselves can act as independent risk factors. To highlight the relation between fluorides and dental caries irrespective of age and gender, a separate comparison was made in each subgroup, age

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groups combined and sex combined, before giving the comparison with both age and sex combined. It is clear from these findings that fluoride concentrations of < 0.7 PPM and > 4 PPM are detrimental to dental health. Race, age, sex, socio-economic status, dietary habits, frequency, time, and type of sweet consumed, level of exposure to fluorides, and oral hygiene practices are some risk factors for dental caries. The study was done on government school children and all the children belonged to the same socio-economic strata. In the absence of statistically significant difference with respect to these risk factors among the study population in different fluoride areas, we can attribute the difference in caries experience to difference in the level of exposure to fluorides. The lack of preventive benefit of fluoride (both topical and systemic) in below optimal fluoride areas may be responsible for high caries experience in this area, compared to optimal fluoride area and high fluoride area where the teeth will have both topical and systemic benefits from repeated exposure to fluoridated water. The subjects in high fluoride areas will have confluent pitting because of severe fluorosis. The morphological alteration in the teeth may facilitate retention of food, predisposing the tooth surface for caries. This may be the possible reason for high caries experience in the very high fluoride area. A study by Budipramana *et al*,[7] found the prevalence of dental caries to be more in either below optimal and high fluoride areas than in optimal fluoride areas. Our study results were in agreement with this study as well as studies by Grobler[8] and Ibrahim *et al*.[9] The mean DMFT score and dental caries prevalence was significantly more among males (0.91 ± 0.98, 59%), compared to females (0.75 ± 0.84, 53.5%) (P = 0.000 and 0.007). There was no statistically significant difference in caries prevalence and the mean DMFT scores between 12 years (55.3%, 0.85 ± 0.94) and 15 years (57.3%, 0.82 ± 0.89) group (P = 0.379 and 0.433) [Tables 2 and 4]. Though a statistically significant difference in the dietary habits and sweet consumption between the gender groups was not noted in the present study, the prevailing social conditions in rural areas of the country provide more liberty in outdoor activities for the boys than for the girls. This may give more freedom for boys to buy sweets like chocolates, candies, etc. than girls, who are relatively reserved and restricted. This to some extent explains the above-noted gender difference in caries experience. Kulkarni *et al*,[2] in their study on 2005 school children in the age group of 11 – 15 years in Belgaum city (Karnataka state, India), found the mean DMFT and caries prevalence to be more among boys (mean DMFT - 1.48, caries prevalence – 45.8%) than girls (mean DMFT - 1.11, caries prevalence - 43.84%). The conclusion was similar to that of our study in terms of gender distribution of caries.

The prevalence and severity of fluorosis increased with an increasing concentration of fluoride in the drinking water (P = 0.000, Table 3). Dental fluorosis is a developmental defect and is related to the level of exposure of the teeth to the fluorides during calcification period. The relation is strongly dose dependent. The higher the level of exposure of tooth during the developmental stages, to increasing concentration of fluoride in drinking water, greater will be the severity of fluorosis. The positive correlation between fluoride concentration and CFI (community fluorosis index) score, was in agreement with the results of studies by Ruan *et al*,[10] Acharya,[11] and Kumar.[12]

There was no statistically significant difference in the prevalence of dental fluorosis between the gender and the age groups (P = 0.536 and 0.108, respectively for gender and age) [Table 3]. The developmental defects like dental fluorosis affect the teeth at the time of calcification (before 10 years of age). Since the calcification of most of the permanent teeth except third molars is complete by 10 years of age, the duration and exposure after this age will not have much influence in determining the severity of fluorosis. This finding was in harmony with that of national oral health survey and fluoride mapping in India.[13] A study by Acharya *et al*,[11] in 5 villages of Davanagere district, Karnataka (India), where the fluoride concentration ranged from 0.43 – 3.41 PPM, found a negative correlation between DMFT score and fluoride concentration in drinking water (R = -0.16). This finding was similar to the finding in our study. There was positive correlation between fluoride concentration and DMFT score in high fluoride area. A positive correlation was noted between fluoride concentration and CFI. These findings were consistent with the findings of studies by Sharma *et al,* in Haryana state, India[14] and Ekanayake *et al*,[15] in Srilanka.

The ministry of health, Government of India has considered 1 PPM fluoride as permissible and 2 PPM as excessive for drinking water. The higher caries experience in areas, where the fluoride concentration is more than 4 PPM, together with a higher community fluorosis index score, demonstrating marked public health significance, suggest an urgent need for defluoridation, at least, in all the areas having this fluoride concentration and

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above. According to our study, an optimum range of fluoride concentration in this area that offered maximum protection against dental caries with minimal risk for esthetically significant fluorosis, was 0.6 – 1.3 PPM. This is very close to the optimal fluoride concentration of 0.6 - 1.2 PPM, suggested by Bureau of Indian standards. The study, though made an attempt to check the "*halo effect*" mediated through other sources of fluoride, such as fluoridated tooth paste, diet etc., further studies are required to precisely define the optimum range for water fluoridation in the country. Defluoridation of course, is a public health priority in this part, as the prevalence and severity of fluorosis is much higher than the prevalence and severity of dental caries.

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